

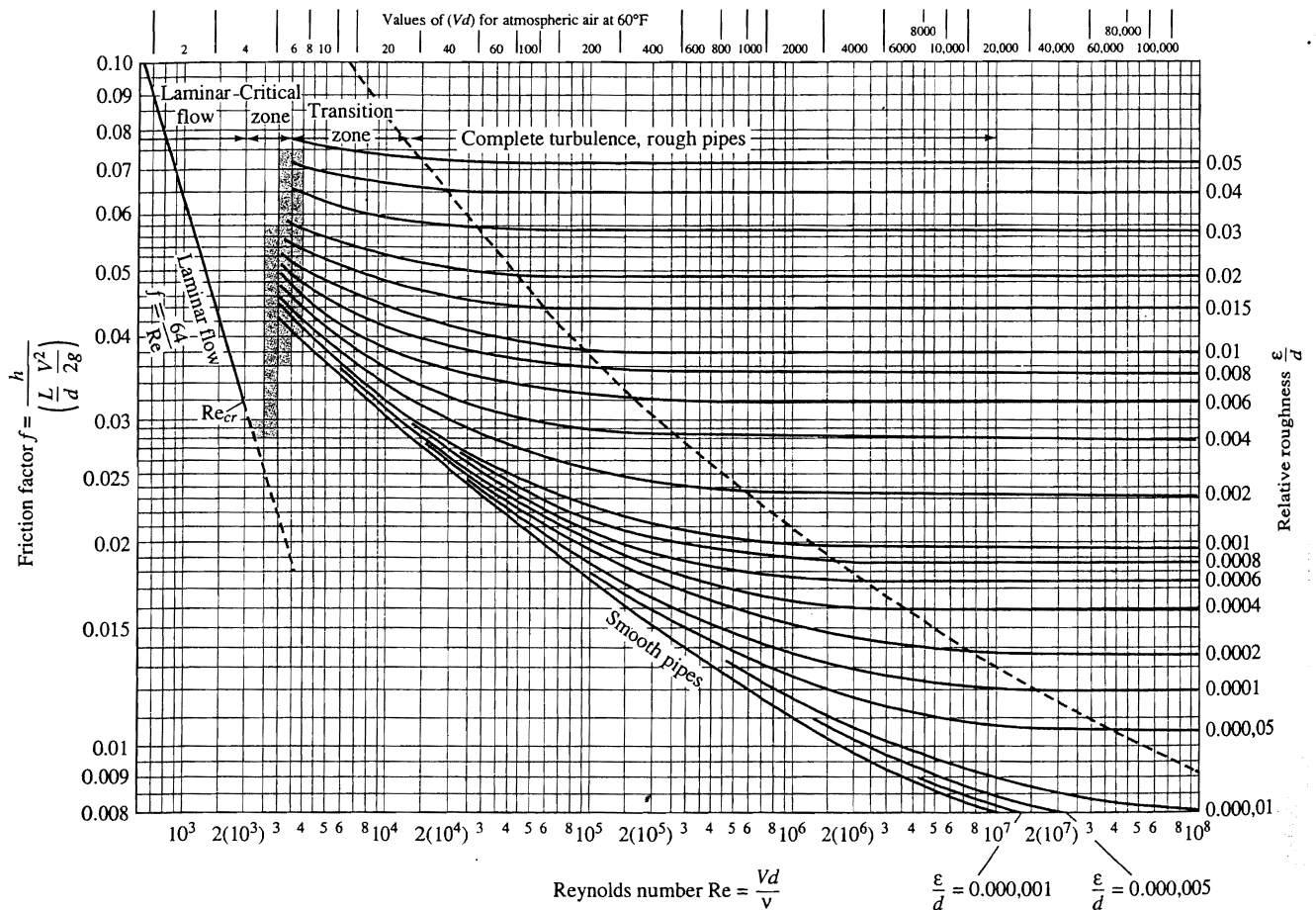
Gambarajah Moody

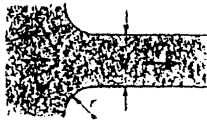



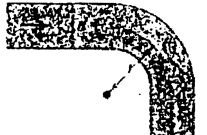
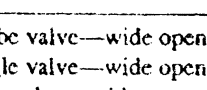
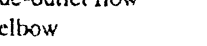
Fig. 6.13 The Moody chart for pipe friction with smooth and rough walls. This chart is identical to Eq. (6.64) for turbulent flow. (From Ref. 8, by permission of the ASME.)

From tests with commercial pipes Moody gave the values for average pipe roughness listed in Table 6.1.

Table 6.1 Average Roughness of Commercial Pipes

| Material (new) | ϵ | |
|----------------------------------|--------------|----------|
| | ft | mm |
| Riveted steel | 0.003–0.03 | 0.9–9.0 |
| Concrete | 0.001–0.01 | 0.3–3.0 |
| Wood stave | 0.0006–0.003 | 0.18–0.9 |
| Cast iron | 0.00085 | 0.26 |
| Galvanized iron | 0.0005 | 0.15 |
| Asphalted cast iron | 0.0004 | 0.12 |
| Commercial steel or wrought iron | 0.00015 | 0.046 |
| Drawn tubing | 0.000005 | 0.0015 |
| Glass | “Smooth” | “Smooth” |

Pemalar Kehilangan pada Pelbagai Sambungan

| Loss Coefficients for Various Pipe Fittings | | | | |
|---------------------------------------------|-------------------------------------------------------------------------------------|----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| Description | Sketch | Additional Data | K | Source |
| Pipe entrance $h_L = K_e V^2/2g$ |  | r/d 0.0 0.1 >0.2 | K_e 0.50 0.12 0.03 | (2)* |
| Contraction $h_L = K_C V_2^2/2g$ |  | D_2/D_1 0.0 0.20 0.40 0.60 0.80 0.90 | K_C $\theta = 60^\circ$ 0.08 0.08 0.07 0.06 0.06 0.06 K_C $\theta = 180^\circ$ 0.50 0.49 0.42 0.27 0.20 0.10 | (2) |
| Expansion $h_L = K_E V_1^2/2g$ |  | D_1/D_2 0.0 0.20 0.40 0.60 0.80 | K_E $\theta = 20^\circ$ 1.00 0.30 0.25 0.15 0.10 K_E $\theta = 180^\circ$ 1.00 0.87 0.70 0.41 0.15 | (2) |
| 90° miter bend |  | Without vanes | $K_b = 1.1$ | (39) |
| | | With vanes | $K_b = 0.2$ | (39) |
| 90° smooth bend |  | r/d | | (5) and (15) |
| | | 1 | $K_b = 0.35$ | |
| | | 2 | 0.19 | |
| | | 4 | 0.16 | |
| | | 6 | 0.21 | |
| | | 8 | 0.28 | |
| Threaded pipe fittings |  | 10 | 0.32 | |
| | | Globe valve—wide open | $K_v = 10.0$ | (39) |
| | | Angle valve—wide open | $K_v = 5.0$ | |
| | | Gate valve—wide open | $K_v = 0.2$ | |
| | | Gate valve—half open | $K_v = 5.6$ | |
| | | Return bend | $K_b = 2.2$ | |
| | | Tee | | |
| | | straight-through flow | $K_t = 0.4$ | |
| | | side-outlet flow | $K_t = 1.8$ | |
| |  | 90° elbow | $K_b = 0.9$ | |
| | | 45° elbow | $K_b = 0.4$ | |

*Reprinted by permission of the American Society of Heating, Refrigerating and Air Conditioning Engineers, Atlanta, Georgia, from the 1981 ASHRAE Handbook Fundamentals.